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HONOLULU LA JOLLA . MONTEREY TIBURON

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COASTAL FISHERIES RESOURCES DIVISION

La Jolla, California

Cooperative Sablefish Cruise Planned

Staff of the Northwest and Alaska Fisheries Center and the Southwest Fisheries Center met in La Jolla on May 4, 1988, to plan the upcoming cooperative sablefish cruise supported by the two centers. The NOAA Ship *Miller Freeman* will be used during the first leg of the cruise in November-December 1988, and the *David Starr Jordan* will be used on the second leg, probably in March 1989. Trawling and ichthyoplankton sampling will be conducted on both legs of the cruise. The general objectives of the cruise are: 1) to explore existing techniques and develop background biological data for estimation of local biomass density and possibly population spawning biomass of the sablefish; 2) to estimate the key biological parameters of size specific depth distribution, egg and larval distribution, and seasonality and rates of reproduction; and 3) provide basic ecological data on the key species of the slope ecosystem. (J. Hunter, FTS 893-7108)

SURVEY SYSTEMS DEVELOPMENT AND EVALUATION

Preliminary Spawning Biomass of the Northern Anchovy in 1988

Dr. Nancy Lo reports that her preliminary estimate of northern anchovy spawning biomass for 1988 is 949,000 mts. She estimated the biomass using the stock synthesis (SS) model, which utilizes three time series of abundance based on egg and larval data, four time series from acoustic trawl survey series, adult age composition, anchovy landings from U.S. and Mexico, and sea surface temperature.

The new data used to compute the 1988 estimate included staged egg data from the CalCOFI (January 19-February 2, 1988) survey, anchovy landings data, and sea surface temperature. The 1987 age composition data from the Mexican fishery were not available in time for the June deadline for the estimate. Consequently, Dr. Lo assumed that the 1987 age composition was the same as that of 1986. The estimate will be revised when the 1987 data are in hand.

Although three anchovy ichthyoplankton time series are used in the SS model, only the modified historical egg production (MHEP) time series could be updated to 1988. The MHEP time series employs only the stations used in the present CalCOFI surveys. The present survey pattern (begun in 1985) employs fewer stations and covers a much smaller area than the earlier surveys. The estimated egg production rate (MHEP) for 1988 was 6.9/0.05m^2/day (SE = 4.83) and is similar to estimates for 1986, 7.2 (SE = 2.57) and 1987, 7.6 (SE = 3.34). But the 1988 estimate was substantially higher than those for 1980-85; the average MHEP was only 3.1.

The surface water temperature of anchovy spawning habitat was lower in 1988 than in recent years. During January-February 1988, the temperature at the Scripps Institution of Oceanography pier was 13.9°C, while in 1986 it was 15.2°C, and in 1987 it was 15.0°C. Temperature of the spawning habitat affects the proportion of one year old fish that attain sexual maturity in a given year, hence the conversion from spawning biomass to total biomass. In 1988 this function indicated that 63% of the fish attained sexual maturity compared to 98% in 1986 and 96% in 1987.

The total anchovy landings at Ensenada during 1987 were 124,00 metric tons (mt) (compared to 96,000 mt in 1986), which is 62% of the 200,000 mt optimum yield. The total landings from the U.S. fishery were 5,900 mt of which 148 mt was for reduction. Landings in 1986 were 5,500 mt.

In summary, the preliminary estimate based on the SS model indicates that the population in 1988 remains at a similar level to that of 1987. If the age composition in 1987 is vastly different from that in 1986, the final results will likely differ from the present estimate. (N. Lo., FTS 893-7123)

Demersal Fish Stocks Assessed off Central California

The Coastal Fisheries Resources Division completed two surveys in 1987 and 1988 of demersal fish stocks of the continental slope of central California (Point Conception to Point Sur California). Both cruises employed swept trawl and ichthyoplankton methods to determine the biomass of commercially important species.

Using densities of fish in the trawl samples and total area of the sampling stratum, Fishery Biologists Dr. John Butler and Carol Kimbrell have estimated the biomass of important demersal fishes in the survey area.

Trawl samples in 1987 were allocated according to a systematic sampling design at depths of 100-700 fathoms and in 1988 by a depth stratified random sampling design. A 400 mesh Eastern trawl was used in both surveys. Area sampled by a trawl was determined from the linear distance traveled by the trawl (1.0-8.2 km) and an estimate of the average mouth opening of the trawl. Butler and Kimbrell used a mean width of 14.6 m for the mouth opening of the trawl. This mean was calculated from 4 measurements made in shallow water which ranged from 13.9 to 15.3 m with a trawling scope of 3:1 (NWAFC unpubl. data, R. Methot, Pers. Comm. 1988). The trawling scope in the survey ranged from 3:1 in shallow water to 1.7:1 in deep water. The mouth opening of the trawl in deep water with reduced trawling scope is unknown. The biomass estimates reported here must be viewed in light of the uncertainty in the mouth opening of the trawl, as well as the catchability of mobile species.

Biomass of five key slope species for the two surveys were:

Biomass (metric tons) ±95% confidence intervals.

Species	1987	1988
Dover sole, *Microstomus pacificus*	15,900(±2,103)	17,300 (±2,000)
Sablefish, *Anoplopoma fimbria*	7,200 (±1,000)	12,000 (±800)
Shortspined thornyhead, *Sebastalobus alascanus*	6,400 (±400)	5,900 (±400)
Longspine thornyhead, *Sebastalobus altivelis*	7,500 (±600)	13,000 (±1,100)
Rex sole, *Glyptocephalus zachirus*	5,300 (±900)	3,800 (±591)

The estimated biomass of Dover sole was remarkably similar between cruises. This estimate of about 15,000 metric tons (mt) is a good indicator of the biomass of this species in the survey area. Age estimates from thin sections of the otoliths indicate the maximum age of Dover sole is about 50 years and a substantial fraction of the fish are older than 20 years (Butler, MS). The fishery takes about 1,000 mt from the Pt. Conception area. This exploitation rate of about 0.07 is consistent with the productivity of the stock. The estimated biomass of sablefish is about 10,000 mt in the survey area. About 350 mt of sablefish are landed per year in Morro Bay, the nearest fishing port. (J. Butler, FTS 893-7149)

COMMERCIAL AND RECREATIONAL FISHERIES RESEARCH FOR MANAGEMENT

Investigating Price Integration in the United States, Thailand, and Philippines Canned Tuna Markets

Industry Economists, Sam Herrick and Dale Squires have conducted a preliminary investigation of price integration in the U.S., Thailand, and Philippines canned tuna markets. Their research addresses a major issue raised during the investigation and hearings conducted by the International Trade Commission (ITC) in 1984 on relief from canned tuna imports (ITC Docket No. 1034, 1984); i.e., price formation and market integration in the Southeast Asian canned tuna markets. A major contention then was that the price of Southeast Asian processed tuna did not respond to changing conditions within the U.S. market, and therefore these markets were not integrated.

The flow of canned tuna from southeast Asia into the U.S. is evidence of market integration on the basis of commodity flows. Herrick and Squires's analysis examines price formation and tests for the existence of market integration on the basis of price in the U.S., Thai, and Philippines markets. If price integration does exist, the degree to which markets are integrated in terms of how rapidly and completely price information is transmitted from one market to another over time is further explored. They focus on the institutional/private label canned tuna market in the U.S. since this is the market that has been most greatly impacted by the rise in imports. They assume that the U.S. is the central canned tuna market and that the Thai and Philippines markets are local markets and thus respond to prices set in the U.S.

To investigate price formation in the Thai and Philippines markets, Herrick and Squires used a dynamic model of spatial price differentials for a

tradeable good. The model permits each local market price series to have its own dynamic structure, allows for influences from local seasonality or other characteristics, and provides for an interlinkage with other local markets.

Using results from the model several tests regarding price integration were performed:

1. Absence of local market characteristics tests whether local market influences as a group are important in local market price formation.

2. Market segmentation tests whether changes in the central market prices have an effect, immediate or lagged, on prices in the local market.

3. Short-run market integration tests whether a price change in the central market will be immediately and fully passed on to the local market.

4. Long-run market integration tests whether a unit increase in the central market price is fully passed on in local market prices within the time period specified (less restrictive than short-run market integration).

The analysis used average monthly wholesale free-on-board prices over the 1983-86 period for U.S. water packed private label, light meat tuna, which were obtained from the Market News Service, NMFS, Southwest Region. Corresponding cost and freight prices in U.S. dollars per standard case for water packed light meat tuna from Thailand and the Philippines were obtained from the FAO GlobeFish Data Base. All prices were adjusted for inflation using GNP implicit price deflators for the respective countries.

Non-price effects include the influence of seasonality which is accounted for by quarterly dummy variables for winter, spring, summer, and fall. Also, the possibility of long-term effects from increasing U.S. imports is captured by a linear time trend.

From the modeling results of price formation in the Thai and Philippines markets the importance of the local market characteristics was first examined. Seasonal dummy variables and the linear time trend did contribute in a significant way to price formation in the Philippine market, but not in the Thai market.

With the U.S. as the central market, the null hypothesis of local market segmentation was not rejected for Thailand and the Philippines. This indicates no market integration by price, and precluded further testing for the extent of market integration.

The preliminary results reveal that the U.S. and Southeast Asian canned tuna markets were probably segmented over the period 1983-1986. In which case, changes in the U.S. market prices would have had no effect, immediate or lagged, on the Southeast Asian markets. Under these conditions, the local market price depends only upon its own lagged values, and in the Philippines, local market conditions as well. Non-price integration might be attributable to predatory pricing strategies on the part of Southeast Asian processors, in which case quotas instead of tariffs would likely be more effective in regulating trade. (S. Herrick, Jr., FTS 893-7111)

Nested Logit Model of Recreational Fishing

Cynthia Thomson, Industry Economist, has analyzed recreational angler decisions regarding fishing site and mode in the context of a nested logit model. The model was estimated with data gathered in a 1985-86 survey of saltwater anglers residing in the coastal counties of central and northern California. The choice set was defined to include (1) six fishing sites (San Francisco Bay proper, San Pablo and Suisun Bays, and four contiguous ocean areas between Bodega Bay and Monterey), and (2) four fishing modes (beach, pier, party boat and private boat).

The discrete decisions were hypothesized to take place in the following sequence: (1) angler decides whether or not to fish; (2) angler decides whether to fish from private boat or from some other mode; and (3) those opting for private boat then decide where to fish. Those opting for some other mode decide which of these other modes (beach, pier, party boat) to fish from, then make a site choice. The reasons for distinguishing between private boat and these other modes in this manner is that they are not likely to be viewed as "co-equal" alternatives by the anglers themselves. In particular, while non-boat owners have relatively unrestricted access to beach, pier,and party boat modes, their access to private boats is limited by the generosity of their boat owning friends and relatives. Boat owners, by virtue of having invested in a boat, have already expressed a prior commitment to

this mode which may supersede other considerations regarding relative species availability or cost.

Site selection was hypothesized to be a function of travel distance (which was used as a proxy for travel cost) and indices of availability for each of the major species targeted in each mode. The target species included in each site choice equation varied by fishing mode as follows:

Beach - striped bass
Pier - surfperch
Party boat - rockfish, sturgeon, albacore, salmon
Private boat - rockfish, sturgeon, salmon, striped bass

An additional "generic" measure of species availability was also included in the beach and pier equations to reflect the fact that a large proportion of trips made in these modes are not targeted at any one particular species.

The empirical results show a negative and statistically significant coefficient for travel distance in all four modes-- indicating that the farther an angler lives from a site, the less likely he/she is to fish at the site. Despite some evidence of multicollinearity, the coefficients on the species availability variables are largely positive and significant--indicating that an increase in species availability at a site also increases the probability that the angler will fish at the site.

The choice among beach, pier and party boat modes was found to be affected by angler characteristics, by on-site costs and by the "inclusive value" of the mode (which measures the "desirability" of the mode in terms of accessibility and species availability). Results indicate that anglers who are employed full-time or who possess intermediate to advanced levels of fishing skills are less likely to fish from piers than from beach or party boat; those who are unemployed are more likely to fish from this mode. Boat owners are less likely to fish from party boats than from beach or pier (by virtue of the fact that they own a boat, they may have less need for the services of a party boat). Retirees are more likely to fish from party boats and anglers with annual household incomes less than $15,000 are less likely to fish from this mode. On-site costs associated with each mode (which include terminal tackle costs and party boat fees) have a negative effect on participation in each mode. For each of the three modes, the coefficient of the inclusive value was positive, indicating that species availability (which is captured in the inclusive value) affects mode as well as site choice.

Results of the upper level mode choice (where the choice is between private boat and any of the other modes) indicate that anglers in general are less likely to fish from private boat than from the other modes. Boat owners are more likely to fish from private boat. Anglers who own boats less than 15 feet in length are less likely to choose private boat than boat owners in general but more likely than anglers in general. This may be due to the fact that small boat owners have made a lesser investment than other boat owners and therefore are less committed to this mode.

The inclusive value coefficients were not statistically significant, indicating that the seasonal changes in species availability which affect the site choice and the choice among beach, pier and party boat modes do not affect the choice between private boat and the other modes. This is not to say that fishery conditions have no effect on private boat use. They may very well affect the frequency with which boat owners go fishing (a subject which is currently being investigated). It would also be instructive to determine whether longer-term (rather than seasonal) expectations regarding species availability affect the decision to purchase or sell a boat. This latter question, however, cannot be answered with the current data set. (C. Thomson, FTS 893-7115)

ECOLOGY AND SYSTEMATICS OF FISHES (CalCOFI)

Preliminary Results of Plankton Work on Groundfish Research Cruise

The Coastal Fisheries Resources Division (CFRD) conducted a research cruise aboard the NOAA Ship *David Starr Jordan* from February 22 to April 9, 1988, along the central California coast to assess stocks of Dover sole, sablefish, and other species of groundfish. This was the second CFRD groundfish assessment cruise; the initial cruise was carried out in the same region from January 11 to February 17, 1987, aboard the *Jordan* (see Report of Activities, May-June, 1987).

The chief purpose of the cruise was to collect ichthyoplankton and bottom trawl samples required to estimate the biomass of central California Dover sole by the egg production method. Other objectives were to: 1) measure biomass of Dover sole using trawl catch rates, 2) continue

work on bathymetric distribution and reproduction biology of sablefish, and 3) continue ecological and community studies of the slope fishes of this region. A total of 66 bottom trawls was made at stations selected by a depth-stratified random technique. At 62 of these stations a surface plankton sample was taken with a Manta net and a standard CalCOFI oblique plankton tow (CalBOBL) was made to 210 m depth with a bongo net. At 44 of the stations, full-water column oblique plankton tows (DBOBL) were made with a modified bongo net. Also, on some stations a 1-m plankton net was attached to the headrope of the trawl, providing 56 non-quantitative plankton samples from near-bottom water. All plankton samples, except those from the trawl headrope, have been sorted and Dover sole eggs have been identified and staged.

Incidence of Dover sole eggs was higher for Manta and CalBOBL samples compared with 1987, whereas incidence in the DBOBL tows was about equal in the two years (Table 1). When tows for 1987 and 1988 were pooled and segregated by month, there was a striking increase in Dover sole egg incidence in the Manta and CalBOBL samples between January and April and a moderate increase in the DBOBL samples for this time period (Table 2). Initial calculations of standardized numbers of Dover sole eggs per positive tow show a slight decrease for Manta net samples from 1987 (mean = 0.15±0.20 SD) to 1988 (mean = 0.09±0.10), a decrease for CalCOFI samples (mean = 36.7±21.45 to 26.0±21.02), and a marked increase for DBOBL samples (mean = 14.0±11.70 to 30.1±21.57). There is no ready explanation for the opposing trends in incidence and standardized counts, especially when viewed in the context of the historical CalCOFI Dover sole larvae files which show larvae are rare from January to March and reach peak abundance in April-June period (see Report of Activities, May-June, 1987). A greater paradox is presented by the data on gonad condition from trawl-caught adults, which show decreasing proportions of females with active ovaries from January to April (see Report of Activities, May-June, 1987, by John Hunter). We will attempt to resolve these questions by making an extensive coast-wide plankton and bottom trawling survey from January to May in 1990.

The geographic distribution of Dover sole egg occurrences in 1988 is shown in the station plot (Fig. 1). There was a tendency for stations to be positive for more than one net type; 13 stations were positive for one net type, 20 were positive for more than one net type and 8 were positive for all

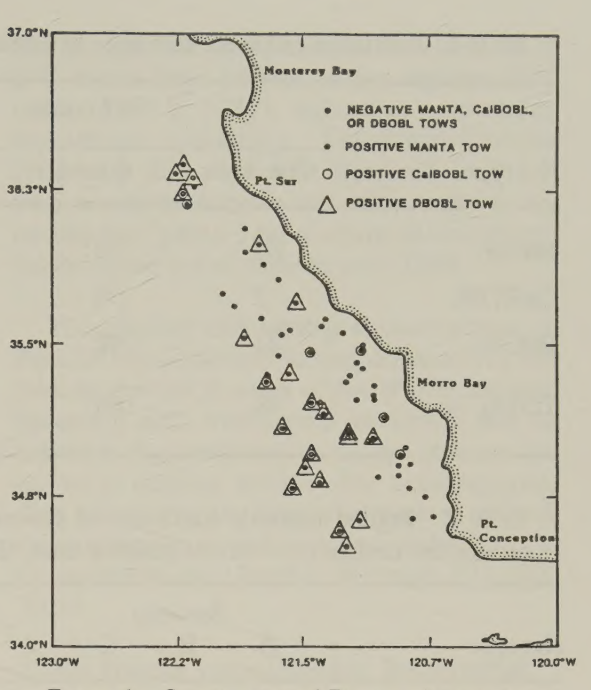


Figure 1. Occurrences of Dover sole eggs in plankton tows taken on 1988 Coastal Fisheries Resources Division groundfish cruise.

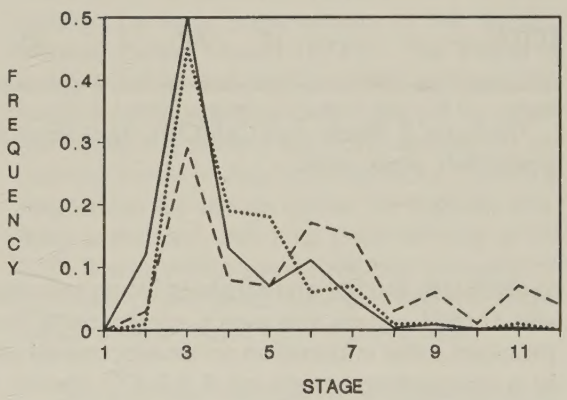


Figure 2. Frequencies of Dover sole egg stages from Manta net samplers pooled for groundfish survey cruises in 1987 (dotted line) and 1988 (dashed line). Solid line represents eight additional Manta tows made in April 1988 in the groundfish survey area.

nets. Also, there was a tendency for negative stations to be in shallower depths and positive stations to be concentrated at the outer edge of the pattern. In future cruises we will extend our plankton stations further offshore to fully encompass Dover sole egg distribution.

The frequency distribution of Dover sole egg stages reveals a large proportion of early-stage eggs in surface waters (Fig. 2). An initial attempt

Table 1. Incidence of Dover sole eggs in Coastal Fisheries Resources Division groundfish cruises.

	1987 cruise			1988 cruise		
Net type	Pos. tows	# tows	%	Pos. tows	# tows	%
Manta	20	73	27	24	62	39
CalBOBL	7	54	13	16	62	26
DBOBL	21	42	50	22	44	50
TOTAL =	48	169	28	62	168	37

Table 2. Pooled monthly incidence of Dover sole eggs in Coastal Fisheries Resources Division groundfish cruises (A = no. of positive tows, B = total no. of tows, C = incidence).

	January			February			March			April*		
Net type	A	B	C	A	B	C	A	B	C	A	B	C
Manta	6	38	16	17	41	41	13	40	33	16	24	67
CalBOBL	1	26	4	7	34	21	8	40	20	15	24	63
DBOBL	7	18	39	14	27	52	13	27	48	9	14	64
TOTAL =	14	82	17	38	102	37	34	107	32	40	62	65

*Includes 8 Manta and CalBOBL tows taken in 1987 on the *David Starr Jordan* Cruise 8704 in the groundfish study area.

to artificially fertilize and incubate Dover sole eggs was carried out on this year's survey cruise and provided some information on developmental rate at a temperature range of 4.3-6.8°C (mean = 5.8 ± 0.71 SD). These data suggest that stage 2 Dover sole eggs taken in surface waters are about one day old, a remarkable ascent from depths approaching 1,500 m for the deepest spawning adults. The eggs hatched after 4 weeks of incubation and continued to hatch for another 10 days. Future incubation experiments will be attempted at warmer temperatures to provide the age/stage calibrations necessary for calculating mortality rates throughout the water column.

Analysis of the plankton and bottom trawl data will provide the basis for an egg production biomass estimate of central California coast Dover sole which will be completed by July 1989. The 1988 survey was accomplished through the dedicated efforts of the entire CFRD staff. Bill Flerx served as cruise leader for the entire cruise and deserves special praise for his outstanding leadership under difficult sea conditions. He was assisted by Dimitri Abramenkoff and Susan Miller on all legs of the survey. Eric Lynn was in charge of collection of gonad data for all legs of the cruise. He also conducted the egg incubation experiment with the assistance of Betsy Stevens. The plankton samples were sorted in a timely manner by Lucy Dunn, Mary Farrell, Alice Lumpkins, and Fran Pocinich. Dover sole eggs were identified and staged by Elaine Acuna, David Ambrose, Barbara MacCall, Betsy Stevens and Lena Shiroma. Paul Smith guided the development of the quantitative deep-water bongo tows. The crew of the *David Starr Jordan* deserve thanks for their help and cooperation throughout the survey. (G. Moser, FTS 893-7129 and R. Charter, FTS 893-7157)

FISHERY-MARINE MAMMAL INTERACTIONS DIVISION

La Jolla, California

FISHERY DEPENDENT ASSESSMENT PROGRAM

Dolphin Ecosystem Task Prepares for 1988 ETP Cruises

Oceanographers Paul Fiedler and Vicky Thayer, aided by Computer Specialist Robert Holland, are preparing for their third oceanographic survey of the eastern tropical Pacific to characterize habitat variability during the 6-year Monitoring of Porpoise Stocks (MOPS) program. MOPS surveys utilize two ships, the *David Starr Jordan* and the *McArthur* from August through November, to census dolphin populations affected by the tuna purse seine fishery. Dr. Fiedler, the survey department on the *McArthur,* AOML Oceanographer Gregg Thomas, and a new Oceanographer replacing Thayer, Lisa Lierheimer, will sample the vertical structure of temperature, salinity, dissolved oxygen, and chlorophyll along tracks using a CTD, rosette sampler, and XBT's. Acoustic backscatter will be measured on the *Jordan* to estimate the abundance and vertical distribution of micronekton. Surface temperature, salinity, and chlorophyll will be measured continuously.

Holland has assembled a data acquisition system for the surface variables. The system consists of an IBM compatible PC and an inexpensive analog/digital board with a versatile Basic program called PCPLUS (Industrial Computer Source). PCPLUS samples the digital signals from the in vivo fluorometer (through the A/D board) and from a thermosalinograph and stores 2-minute averages. The program has been modified to handle calibration and blanking of the fluorometer and will greatly simplify collection and processing of these data.

In 1986, and especially in 1987, the dolphin ecosytem task observed an anomalous environment in the ETP, caused by the 1986-1987 El Niño. Surface temperatures were 1-3°C above normal. The thermocline was deeper than normal along the equator but shallower at the 10°N ridge. Chlorophyll levels were significantly lower in 1987 than in 1986, although the subsurface temperature structure was returning to normal. In May and June 1988, sea surface temperatures have been up to 2°C colder than normal at the equator (5°C colder than in 1987), indicating very strong equatorial upwelling. Francisco Chavez (Monterey Bay Aquarium Research Institute), who is collaborating in this effort, reports unusually high primary productivity at stations occupied along the equator in early 1988.

The physical and biological environment in the ETP is thus likely to be very different in 1988 than in the first 2 years of the MOPS surveys. Assessing such interannual variability will be critical in the interpretation of any changes observed in dolphin stocks. The oceanographic data collected by the dolphin ecosystem task will show cetacean abundance and distribution in the eastern tropical Pacific. (P. Fiedler, FTS 893-7016)

TOPS Tracks Tuna-Dolphin Trajectories

Drs. Elizabeth Edwards and Pierre Kleiber, Fishery Biologists, have developed a computer model (TOPS; Tuna-vessel Observer Program Simulator) that simulates the process of "dolphin fishing" by tuna purse-seiners in the eastern tropical Pacific Ocean (ETP). The model is being used to test and evaluate methods for using dolphin sightings data collected by scientific observers aboard the purse-seiners for estimating trends in dolphin abundance. NMFS is responsible for setting quotas for dolphin mortality associated with tuna purse-seining in the ETP. These quotas are determined primarily on the basis of estimated trends in dolphin abundance as determined from sighting data.

Two sources of sightings data are available for making these estimates: data collected by observers on tuna vessels, and data collected during research vessel surveys. NMFS has traditionally relied most heavily on the research vessel data because of suspected but unquantified biases in the tuna vessel data. But data collected by observers aboard tuna vessels are much more abundant and less expensive to collect than the research survey data, so NMFS has begun a research program to assess the utility of observer data for estimating dolphin abundance. Kleiber and Edwards' model is one aspect of that program.

Three versions of the model operate currently. A small version, simulating only a subset of the full model, runs as a demonstration package

on an IBM-AT equipped with extended graphics adapter output. The other two versions each simulate a 1200 x 1200 nm area of the ETP. One version, used for program development, runs on a Stride (32-bit) microcomputer. The other version runs on the Cray supercomputer at the San Diego Supercomputer Center. This third version produces output that is subsequently transformed into 16 mm movies depicting various sets of conditions, the movements of simulated tuna purse-seiners, and dolphin schools in the ETP.

Both versions of TOPS are unique among fishery models in tracking the position of each school and vessel exactly in space and time, rather than moving the objects between boxes in a grid, as is usually done with models of this type. This exact positioning is necessary to properly simulate the collection of dolphin sightings data from tuna vessels because the model must be able to resolve distances of less than 5-10 nm between vessels and schools. It is both more versatile and more efficient computationally to track movements of individual objects than to create thousands of small grids.

Based on reported fleet sizes and estimates of dolphin school density in the ETP, the large model includes 2500 dolphin schools and 75 tuna vessels. Movements of dolphin schools are controlled by an underlying "environmental topography" that causes the schools to aggregate more or less tightly, depending on the parameters chosen for the topography. Movements of tuna vessels are controlled by the sighting history of each vessel; vessels tend to remain in areas where schools have been sighted and to leave areas where schools have not been seen. Movement rules for both schools and vessels incorporate a random element so that movements are never pre-determined exactly. This incorporates implicitly "unexplained" variability in both environmental conditions and movement decisions by schools and vessels. The environmental topography chosen for the first set of simulations is a regular grid of alternating peaks and valleys, generated as a function of interacting sine waves. Topographies more specific to the ETP will be used in later simulations, based on oceanography data being collected currently by SWFC researcher Dr. Stephen Reilly.

Starting with a completely random spatial distribution of vessels and schools, the movement rules and environmental topography cause the dolphins to aggregate over time near the peaks, which represent desirable areas of the environment and the vessels to search most heavily in these areas of school concentration. Though relatively simple, the movement rules in the TOPS model generate aggregations of schools and vessels on scales and in patterns that simulate well patterns and scales observed in TVOD.

The first simulations tested the effects on line transect estimates of school density (schools/1200 nm^2) caused by increasingly complex environmental topographies. Simulations showed that increasing complexity could bias seriously the estimates, primarily due to interactions between sampling frequency (sightings data aggregated by 1-degree squares) and the scale of environmental topographies. Results of these first simulations were presented by Edwards and Kleiber at the 39th Annual Tuna Conference at Lake Arrowhead, CA, on May 16, 1988, and the Annual Meeting of the Association of Resource Modellers in Ensenada, Mexico, on June 15, 1988.

In addition to these simulations, TOPS has applications both for further analysis of observer data and for analyses of factors affecting the tuna fishery itself. Edwards and Kleiber will use TOPS to test proposed new methods for estimating trends in dolphin abundance from observer data. Testing the methods first with TOPS provides a cost-effective way to evaluate new analytical methods without having to mount expensive and difficult field experiments. In addition, the model will be used to evaluate the effects on sighting rates (and by implication, fishing success) of varying characteristics of the fleet itself. These will include for instance, the effects of code groups versus fishing independently, stationary versus migratory aggregations of dolphins and tuna, effects of different fishing strategies such as risk-taking versus conservative behavior, and log versus school versus dolphin fishing, and effects of different economic climates on optimal fishing strategies. (L. Edwards, FTS 893-7099)

FISHERIES INDEPENDENT ASSESSMENT PROGRAM

California Sea Lions Censuses

In July, Operations Research Analysts Rennie Holt and Peter Boveng traveled to Santa Barbara Island (SBI) where they censused California sea lions as part of the FMMID's continuing coastal marine mammal monitoring program. Although

SBI is a small island, the steep cliffs and caves which border the sea lion rookeries make aerial photogrammetric censusing of the animals impossible to do safely and reliably. The sea lion pups of the year, the age-class providing the most reliable indicator of trend in population size, are counted with binoculars and telescopes from vantage points on the cliff tops, or by moving carefully through the rookery and counting at close range where access is possible. The 1988 pup count was 1,089, an increase from 917 and 814 in 1987 and 1986, respectively. When combined with the ground count from San Clemente Island (SCI) and the aerial photo counts from San Nicolas Island (SNI) and San Miguel Islands, the SBI count will be used to update the assessment of sea lion population status.

The ground counts at SBI and SCI provide the opportunity for FMMID staff to collect sea lion scats which are used by Fishery Biologist Mark Lowry to analyze sea lion feeding habits. About 50 scat samples were collected on the July trip to SBI. The results of the food habits analysis from SBI will be integrated with those from SCI and SNI and used in a log term study of interactions between fisheries, the sea lions, and environmental variations such as El Niño. (P Boveng, FTS 893-7173).

HONOLULU LABORATORY

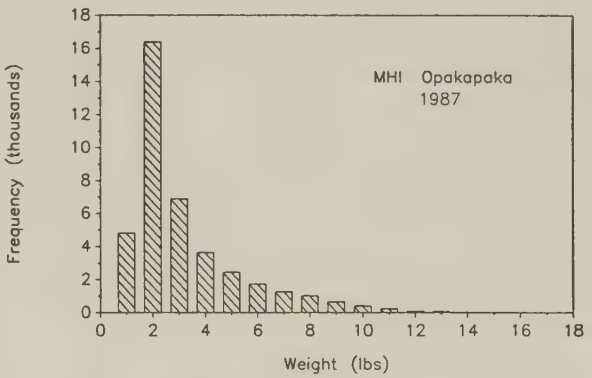
Honolulu, Hawaii

INSULAR RESOURCES INVESTIGATION

Annual Assessment of Hawaii's Bottom Fish Fishery Completed

Bottom fish landings from both the main Hawaiian Islands (MHI) and the Northwestern Hawaiian Islands (NWHI) increased at an average of 12% annually from 1984 to 1987. That's according to an Administrative Report entitled "A biological assessment of Hawaiian bottom fish stocks, 1984-87," by Stephen V. Ralston, Task Leader of the Insular Stock Assessment Program, and Kurt E. Kawamoto, Biological Technician. Ralston and Kawamoto also reported that significant alterations occurred in species composition during that time period. The catch of opakapaka, *Pristipomoides filamentosus*, the single most important of 12 species in the fishery, declined from 181 to 159 metric tons (mt) in 1984-86. However, 1987 saw a reversal of this trend, with record opakapaka landings (195 mt). The fishery in the NWHI accounted for over two-thirds of the total landings in 1987.

The present management plan for Hawaii's bottom fish requires that the biological status of the fishery be evaluated each year by the Plan Monitoring Team of the Western Pacific Regional Fishery Management Council. Based on the Team's findings, a report is issued describing the status of the stocks. The annual report also provides the scientific basis for recommendations concerning the implementation of new management measures. The Council's annual bottom fish stock assessment has largely been the result of work completed by the Honolulu Laboratory. Ralston and Kawamoto's report is a module in the annual report.



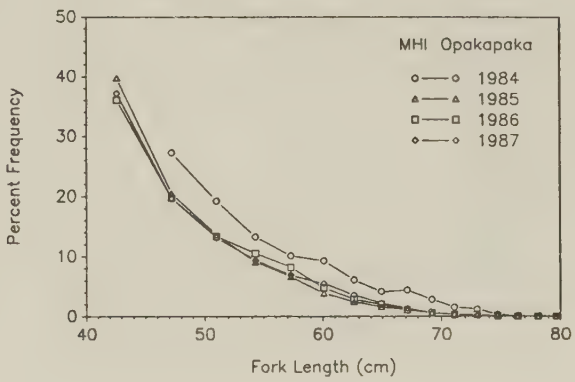


Figure 1 (top). Figure eight-frequency distribution of opakapaka in the main Hawaiian Islands, based upon 1987 market samples.

Figure 2 (bottom). Descending limbs of relative length-frequency distributions of opakapaka from the main Hawaiian Islands in 1984-87.

The bottom fish fishery in Hawaii is monitored by gathering data at the Honolulu wholesale fish market. Although representing only a subsample of total commercial and recreational bottom fish landings, the market is the most centralized point at which a large volume of fish can be intercepted. In 1987, the amount of bottom fish passing through the market substantially exceeded the State's reported commercial landings. Therefore, trends and patterns observed in the wholesale data are believed to be indicative of the fishery as a whole.

Statistics on fishing effort and catch per unit effort in the NWHI, which is almost exclusively under Federal jurisdiction, indicate generally favorable biological conditions in the fishery. The catch of bottom fish per fishing trip has risen every year in this region since data collection began. Likewise, the trend in declining catch rate of opakapaka reversed in 1987; the catch rate rose almost 30%.

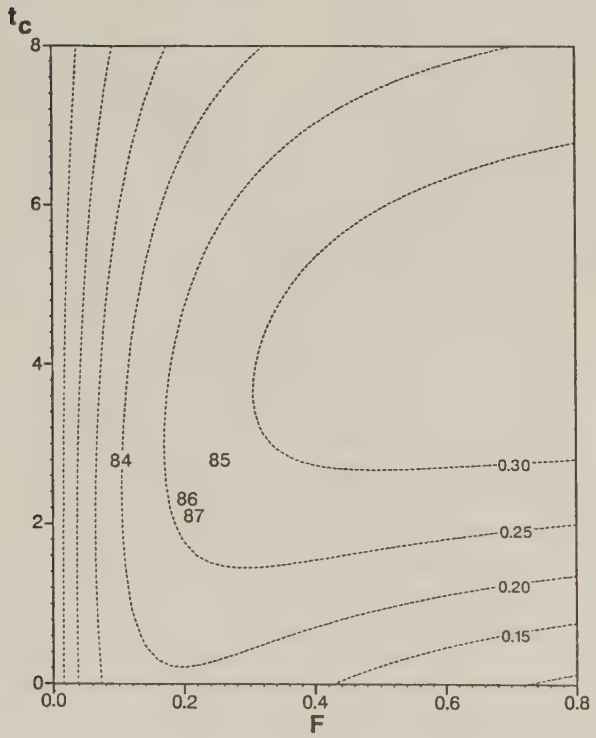


Figure 3. Yield-per-recruit analysis for opakapaka from the main Hawaiian Islands in 1984-87. The unit of fishing mortality (F) is yr^{-1}, and the unit of age at entry (t_c) is years. Contoured isopleths represent the locus of points corresponding to equal yield per recruit (in kilograms). Changes within the fishery are shown on an annual basis.

In contrast, the MHI bottom fish fishery appears to be more severely stressed. Jurisdiction over the resource in this region is shared between Federal and State authorities. Size-structured analyses of key species indicate the MHI fishery is predominantly growth-overfished. This is primarily due to an extensive harvest of undersized, juvenile fish, as opposed to excessive levels of fishing effort. For example, although opakapaka grow as large as 8.2 kg (18 lb), the modal size of MHI landings in 1987 was only 0.9 kg (2 lb) (Fig. 1). Likewise, there has been a trend towards harvesting increasingly smaller opakapaka over time (Figs. 2, 3). Many of the most important fishes in this multispecies fishery are now harvested well before they reach reproductive maturity, increasing the likelihood of recruitment-overfishing (Fig. 4).

Based on the evidence of growth-overfishing, implementation of minimum size limits on the commercial sale of bottom fish has been advanced as a recommendation to the Council. Further study will be required to determine exactly what these size limits should be. Ralston and Kawamoto's report is available as Southwest Fisheries Center Administrative Report H-88-8. (S. Ralston (808) 943-1259)

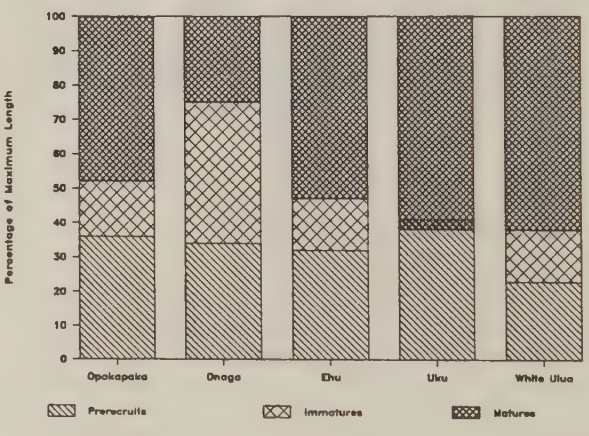


Figure 4. Relationship of length at entry to the fishery (l_c) and length at maturity (l_m) to maximum length for five bottom fish species from the main Hawaiian Islands. In each case, the lower "prerecruit" portion represents the lifespan up until l_c. The middle "immature" portion indicates the range during which fish are harvested but have not had the opportunity to reproduce (i.e., prior to l_m). The top "mature" portion displays that part of the lifespan during which breeding takes place. (Onaga = *Etelis coruscans*, ehu = *E. carbunculus*, uku = *Aprion virescens*, and white ulua = *Caranx ignobilis*.)

PELAGIC RESOURCES INVESTIGATION

Hawaii's Fresh Tuna Fishery Flourishes

Hawaii's fresh tuna fishery is flourishing, even by national standards, according to an estimate made by Fishery Biologist Christofer H. Boggs and Industry Economist Samuel G. Pooley. The 1987 ex-vessel value of Hawaii's fresh tuna catch was about $20 million (6,000 short tons of fish), compared to $200 million (254,000 short tons of fish) for the ex-vessel value of the U.S. tuna canneries' domestic receipts (Tuna Newsletter, No. 89, May 1988). (The U.S. canneries also purchase tuna from foreign vessels.) Information on landings of fresh tuna on the U.S. mainland is not available. Hawaii tuna prices ($1.71/lb or $3,400/short ton) are substantially higher than the U.S. canneries' prices ($600-1,000/short ton). The U.S. canneries were paid even less for fish weighing lb. (C. Boggs (808) 943-1222)

Hawaii's Aku Catch Forecasted for 1988

The sea-surface temperatures indicate good fishing for large aku (skipjack tuna, *Katsuwonus pelamis*) in Hawaii in 1988, according to the aku forecast by Fishery Biologist Christofer H. Boggs. The corrected 1988 forecast predicts the baitboat catch per boat per day fished will be about 1,200 lb for large aku and 3,200 lb for all sizes landed. Large aku will be more available to fishermen than in 1974-83 but not as available as in the best years (1965, 1972, and 1973). The total baitboat catch in 1988 should be about 3 million lb (Fig. 5). With a larger market, the same number of boats fishing the same number of days could yield an additional 2 million lb.

The 1988 forecast used the sea-surface temperature isotherms east of Hawaii to predict the average, annual catch rates of aku. The month-to-month movements of the isotherms explain a large percentage (68%) of the annual changes in the availability of large aku. At least this was true until 1984, when the cannery closed (Fig. 6). Since then, catch rates of large aku have been lower than the National Marine Fisheries Service forecasts because the baitboat fleet has limited its catch to avoid flooding the market. Thus, the 1988 forecast was corrected to account for the market limitation. The uncorrected forecast predicts 2,200 lb for large aku (Fig. 6) and 5,000 lb for all sizes landed.

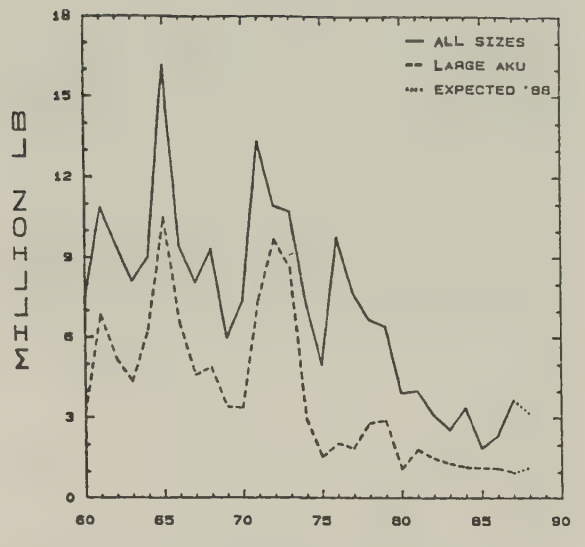


Figure 5. Past aku (skipjack tuna) catch and expected catch.

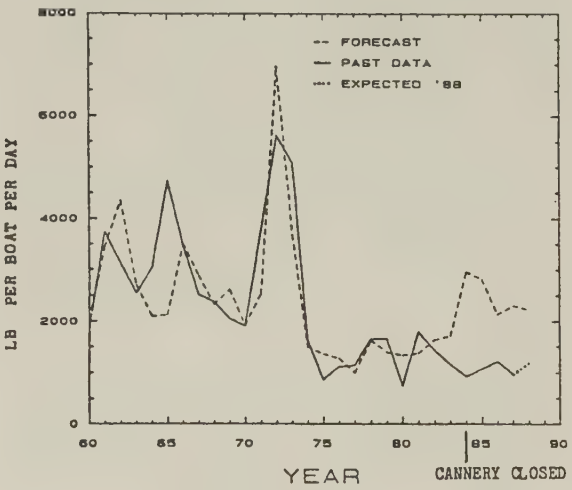


Figure 6. Annual large aku (skipjack tuna) catch rate.

As in 1987, the actual catch rates during the first 3 months of 1988 were higher than typical, especially for large aku. In this sense, 1988 has already been a good year. Based on the corrected forecast with the market limitation, catch rates for the remainder of 1988 should stay at similar levels. (C. Boggs (808) 943-1222)

Two Manuscripts on Tuna Completed

Two manuscripts reporting a study on the physiological reactions and tolerances of tunas to low ambient oxygen were recently completed by Fishery Biologist Richard W. Brill and Peter

Bushnell, a graduate student at the University of Hawaii's Department of Physiology. The overall purpose of the study was to determine how oceanographic conditions limit tuna habitat and affect their movements, abundance, and vulnerability to specific types of fishing gear.

One manuscript deals with cardiorespiratory variables measured in three species of tuna spinally blocked with Lydocaine (see Fig. 7 for experiment apparatus): skipjack tuna; yellowfin tuna, *Thunnus albacares*; and bigeye tuna, *Thunnus obesus*. Although unable to swim, the tuna could be maintained and studied in a physiologically normal condition for up to 12 hours. Ventilation volumes, measured by dye dilution, in tunas in fully oxygenated seawater ranged from 1.5 to 6.7 L min^{-1} kg^{-1} for bigeye and skipjack tunas, respectively. Oxygen consumption ranged from 322 to 740 mg O_2 kg^{-1} h^{-1} for bigeye and skipjack tunas, respectively. Mouth gape (i.e., size of the mouth opening that controls the volume of seawater passing over the gills), heart rate, expired P_{O2}, and relative cardiac output were also measured.

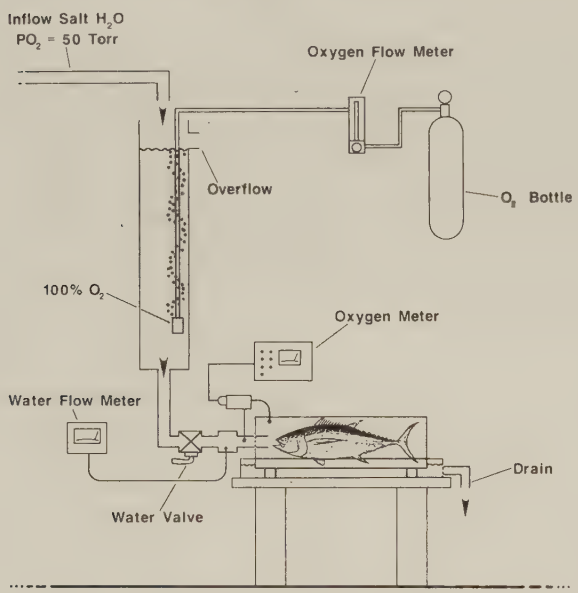


Figure 7. Diagram of the experimental apparatus used to measure changes in cardiorespiratory variables in restrained and spinally blocked tunas exposed for brief periods to lowered ambient oxygen.

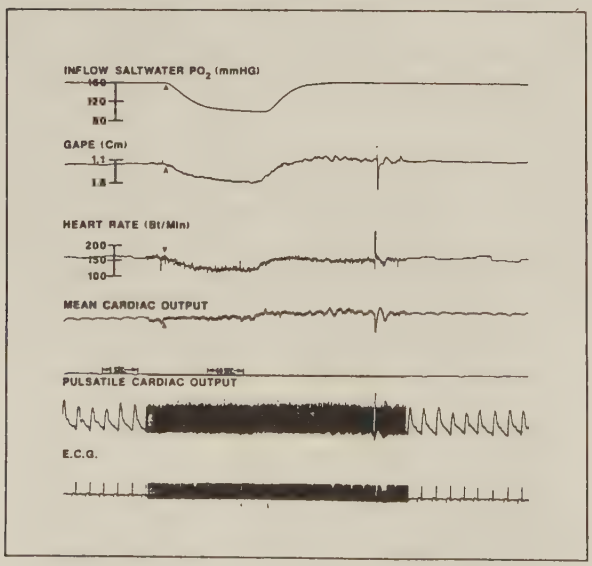


Figure 8. Changes in cardiorespiratory variables in a restrained and spinally blocked skipjack tuna.

All three species of tuna were very sensitive to oxygen levels of the inspired water. When exposed to mild reductions in ambient oxygen (a 30% reduction in oxygen level), compensatory cardiorespiratory adjustments were initiated. The first responses were increases in mouth gape and ventilation volume, which were accompanied by slowing of the heart rate (bradycardia) as hypoxia became more severe. Cardiac output was maintained to about 60% of full oxygen saturation. Below that level, cardiac output also began to decrease.

Results suggest that skipjack tuna are the least hypoxia tolerant of the three species studied. In skipjack tuna, changes in the oxygen concentration of seawater, mouth gape, and heart rate were almost simultaneous (Fig. 8). The cardiac output in all tunas studied was maintained, despite falling heart rate, by compensatory increases in stroke volume (i.e., the amount of blood pumped per beat).

The second manuscript describes a computer program, called CARDIO, that rapidly and semi-automatically calculates cardiac output from dye or thermal dilution curves. Calculating cardiac output from indicator dilution curves is a common physiological research technique, which was employed during the study on the reactions of tunas to lowered ambient oxygen. Originally developed for in-house use, CARDIO has proved to be very powerful and flexible.

The computer program CARDIO is based on a Lotus 1-2-3 template and a complex and lengthy series of macrocommands. CARDIO will work with any dye or thermal dilution recorder with an analog output, any computer capable of running Lotus 1-2-3 version 2, and any analog to digital (A-to-D) conversion system.

Therefore, it employs equipment already common in many laboratories.

CARDIO imports the indicator dilution curve data into a Lotus 1-2-3 template. Then the data points can be selected for baseline and for use in the semilogarithmic extrapolation of the indicator concentration curve's downslope. This extrapolation is needed because of the recirculation of the dye or heat pulse through the circulatory system. After extrapolating the curve's downslope, CARDIO calculates the area under the curve and the cardiac output. By using CARDIO, the entire process from importing the data file to final calculation of the cardiac output can be performed in min.

A sample dye dilution curve, with the downslope extrapolated by CARDIO, is in Figure 9. Only by use of computer-automated data collection, storage, and manipulation could data collection rates as high as those in Figure 9 be accommodated. The analog-to-digital converter sampled the dye curve at 10 samples per second, compared to the usual sampling rate of 1 sample per second for data manually gathered and processed. (The relatively high-frequency, A-to-D conversions of indicator dilution curves improve the accuracy of cardiac output measurements.) Because CARDIO is menu driven, no prior experience with Lotus 1-2-3 is needed, but experienced users can take full advantage of Lotus 1- 2-3's graphics, data manipulation, and data retrieval capabilities. (R. Brill (808) 943-1266)

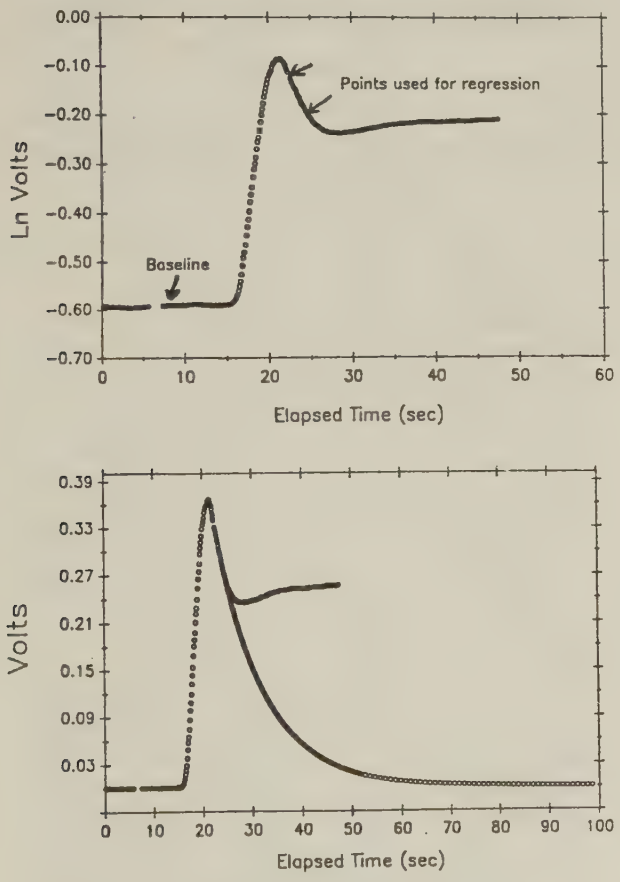


Figure 9. Examples of the original dye dilution data set (top) and the extrapolated data produced by CARDIO (bottom). The point at which the dye begins to recirculate can be clearly seen.

Ichthyoplankton Cruise Completed

An ichthyoplankton survey was conducted on the windward and leeward coasts of the Hawaiian Island of Oahu from the NOAA Ship *Townsend Cromwell*, 23 April-3 May 1988. Second in a series of three planned research cruises, the cruise (TC-88-03) had several objectives: collect pelagic management unit species (PMUS) larvae and juveniles to investigate their distribution in time (this period will be compared to October 1987 and September 1988) and space (onshore-offshore), 2) collect and preserve mahimahi, *Coryphaena hippurus*, and ono (wahoo), *Acanthocybium solandri*, larvae for use in studying date of hatching and growth aspects of recruitment, 3) collect oceanographic data to augment the ichthyoplankton survey, and 4) collect ovaries of mahimahi and ono with known time-of-capture for aging ovarian atresia.

All objectives of the cruise were met. Regarding objective 1, all 26 planned sites for ichthyoplankton collection were successfully sampled by the Manta neuston net (day and night) and the 6-ft Isaacs-Kidd midwater trawl (night only). Six additional collection sites were sampled as well. Four collection sites were added along a northeast transect from Kahuku Point, Oahu, where plankton catches were very high.

For objective 2, all ichthyoplankton samples were preserved in alcohol to allow for examination of larval otoliths. Inspection of the catches at the time of preservation and without the aid of a microscope revealed the presence of juvenile mahimahi in samples containing debris and tar balls (for collection areas, see cross-hatching in Figs. 10, 11). Two larval swordfish, *Xiphias gladius*, have been found in the dozen samples sorted to date.

All XBT and CTD casts were successfully conducted at predetermined sites for objective 3. Surface (bucket) temperatures and salinity at XBT sites off the leeward Oahu coast were plotted and contoured (Figs. 10, 11). Doppler current profile was recorded throughout the cruise. Physical environmental data from the water's surface are important because most PMUS larvae are caught there.

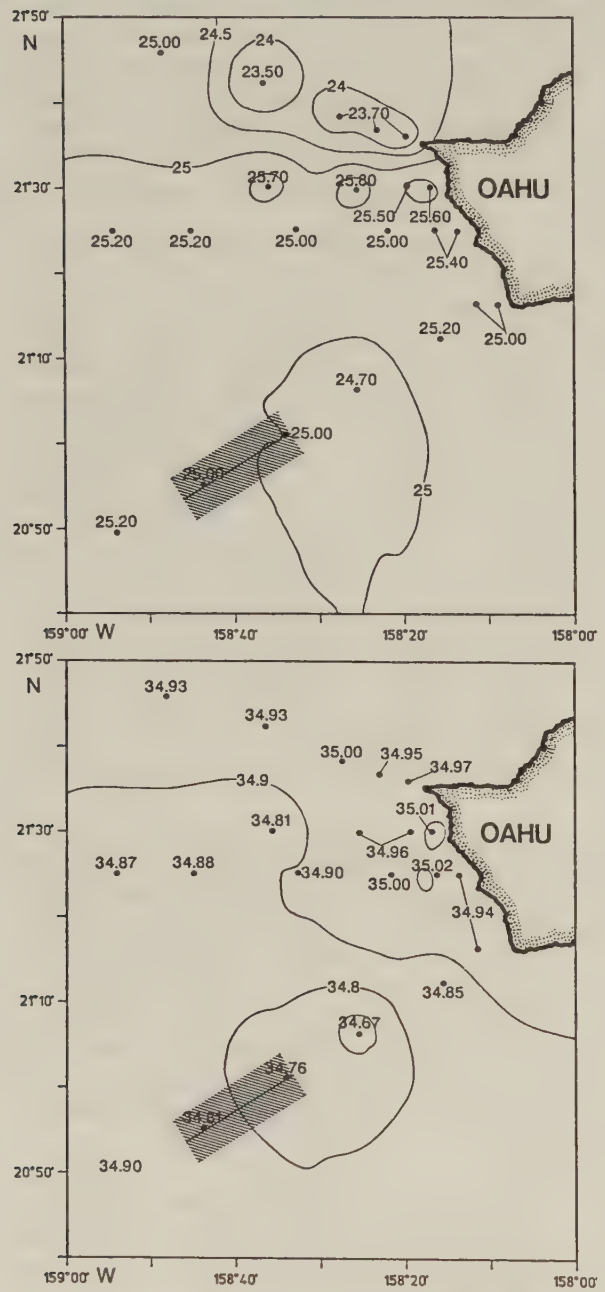


Figure 10 (top). Surface temperatures at XBT sites off the leeward Oahu coast, 23 April-3 May 1987. Cross-hatching indicates collection area of samples containing debris and tar balls.

Figure 11 (bottom). Salinity at XBT sites off the leeward Oahu coast, 23 April-3 May 1988. Cross-hatching indicates collection area of samples containing debris and tar balls.

For objective 4, ovaries from a mahimahi were obtained. Trials on keeping mahimahi alive in the baitwell were attempted. The fish did well in calm water but did not survive in rough water when the ship traveled to the plankton stations at night.

Cruise participants on the *Cromwell* were Field Party Chief Robert A. Skillman, Fishery Biologists Bruce C. Mundy and James H. Uchiyama, and Research Assistants Donald Kobayashi and Dennis Therry. (R. Skillman (808) 943-1257)

FISHERY MANAGEMENT RESEARCH PROGRAM

Western Pacific Pelagic Fisheries for 1987 Examined

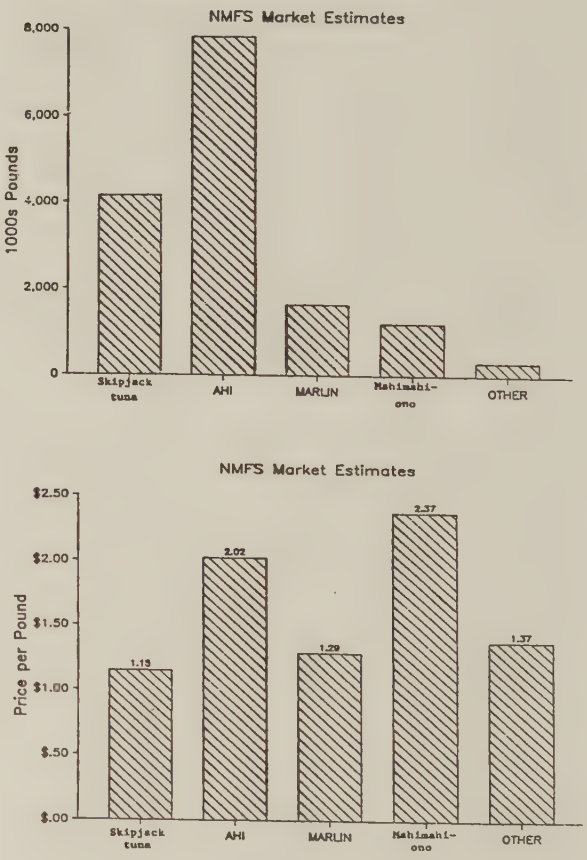


Figure 12. Hawaii pelagic landings (top) and prices (bottom) in 1987 (ahi = albacore, bigeye, and yellowfin tunas).

The total landings of the Hawaii pelagic fishery in 1987 equaled an estimated 15 million lb, worth $24.8 million (Fig. 12), according to "Western Pacific Pelagic Fisheries in 1987," an Administrative Report recently completed by Industry Economist Samuel G. Pooley. The report examines the billfish and tuna fisheries and markets in Hawaii, as well as in American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands.

In Hawaii, estimated yellowfin tuna landings were 5.6 million lb ($7.5 million), compared to 2.8 million lb ($4.6 million) for landings of the pelagic management unit species (billfish, mahimahi, ono (wahoo), and sharks). The estimates are based on extrapolations from the Honolulu Laboratory's shoreside monitoring program and considerably exceed the official State of Hawaii figures for 1987. The Honolulu Laboratory's estimates indicate the considerable growth in the longline and handline tuna fisheries, as well as the sustained performance of the fresh mahimahi and ono fisheries. The report is available as Southwest Fisheries Center Administrative Report H-88-11. (S. Pooley (808) 943-1216)

MARINE MAMMALS AND ENDANGERED SPECIES PROGRAM

Headstarted Female Monk Seals Contributing to Births at Kure Atoll

This year, female Hawaiian monk seals, *Monachus schauinslandi*, who were themselves part of the Headstart Project in the early years are contributing significantly to the number of births at Kure Atoll in the Northwestern Hawaiian Islands, according to Fishery Biologist John R. Henderson. Of the eight pups born at Kure Atoll so far this year, half were from head started females. Begun in 1981, the Headstart Project gives female pups born at Kure Atoll a headstart in life by protecting them from attacks by sharks or aggressive male seals during their first few months after weaning, when they are most vulnerable. (Male pups are not maintained because adult male seals at Kure Atoll outnumber the females by 2:1.) The project was initiated in an attempt to enhance the survival rate of pups at Kure Atoll, where seal births had declined from about 30 in the late 1950's and the 1960's to a low of 1 birth in 1986 because of poor survival of pups and resultant low recruitment of reproductive females. Since then, pupping has increased as a result of the Headstart Project: Births numbered six in 1987 and eight so far in 1988. In the 7 years since the project's inception, 16 pups have successfully completed their first summer in the protective enclosure, where they are fed locally caught reef fishes and invertebrates as they grew in size and learned to forage on their own.

Particularly encouraging is that the Headstart Project has entered its "second generation"; that is, four females who were themselves maintained by the project in 1981 or 1982 have given birth this year. Three of their pups are female and are currently being maintained in the enclosure. A fourth female pup, born to an older, non-headstarted mother, also is in the enclosure. Three of the remaining four pups are male, and one of unknown sex is still nursing as of June 28. (J. Henderson (808) 943-1225)

PELAGIC FISHERIES RESOURCES DIVISION

La Jolla, California

MULTISPECIES DATA COLLECTION AND EVALUATION PROGRAM

Tuna Purse Seine-Associated Dolphin Mortality

The air-breathing dolphins are often found in association with schools of yellowfin tuna. Tuna fishermen in the eastern tropical Pacific encircle the aggregation with purse seine nets, accidentally killing dolphins before they can be separated from the tuna and safely released from the nets. The National Marine Fisheries Service monitors this dolphin mortality by placing observers aboard U.S. tuna purse seiners. The data collected by the observers are processed and evaluated by scientists of the SWFC.

Data on the incidental dolphin mortality were summarized for a poster presentation at the 39th Annual Tuna Conference, Lake Arrowhead, California. The average dolphin kill per set decreased in 1987 to 2.93, down from the 1986 rate of 8.03. The kill per set has remained fairly constant over the past 10 years, after decreasing from a high rate of 10 dolphins per set in the early 1970s. The frequency of high kill sets--sets in which more than 15 dolphins were killed--has also decreased. High kill sets in 1987 accounted for 4.3% of the total sets on dolphins, down from

20% or higher in the early 1970s. (A. Jackson, FTS 893-7048)

1987 North Pacific Albacore Fishery Data

A poster was presented, by the Multispecies Data Collection and Evaluation Program, at the 39th Annual Tuna Conference, Lake Arrowhead, California, summarizing data collected from the 1987 U.S. North Pacific fishery for albacore. Catches continued downward to a record low for the fishery of approximately 3,000 mt in 1987 (record high was in 1963 at 28,700 mt). Catch rates also declined from 117 fish per day in 1986 to approximately 70 fish per day in 1987. The average size of fish was 14.9 lbs in 1987, slightly smaller than the 15.7 lbs in 1986. Highest catches and catch rates were centered off northern California and Oregon as in 1986. The low catch is attributed to decreased participation in the fishery owing to fishermen switching to salmon fishing, which was more profitable in 1987. (A. Coan, FTS 893-7079 and A. Majors, FTS 893-7077)

First Quarter Statistics for the Seychelles Purse Seine Fishery

First quarter 1988 purse seine data from the Seychelles fishery in the Indian Ocean were computerized for easy handling by Al Coan, Leader of the Multispecies Data Collection and Evaluation Program. Participation in the fishery during the first quarter of 1988 increased to 39 purse seiners from 33 during the same period in 1987. Estimated catch (approximately 74% logbook coverage) for the first quarter of 1988 was 39,160 mt, an increase of 15% from catches in 1987. The species composition of the catch was 72% yellowfin and 28% skipjack. Record high catch rates were recorded in March of 22.7 fish per day's fishing. (A. Coan, FTS 893-7079)

STOCK ASSESSMENT AND FISHERY IMPACT ANALYSIS PROGRAM

Cooperative Marine Game Fish Tagging Program - 1987 Results

In 1987 billfish anglers tagged and released 1,570 billfish, an increase of 336 billfish tagged over the number tagged in 1986. In addition, anglers used billfish tags to tag 74 other species of fish and sharks (species other than billfish) for a total number of fish tagged of 1,644 fish. Billfish tagged were: 1,150 striped marlin, 254 blue marlin, 26 black marlin, 125 sailfish and 11 short-billed spearfish.

Table 1. Summary of billfish tagging by area and species--1987.

Area		Total
Pacific Ocean		
Australia	Black marlin	13
	Blue marlin	1
Hawaii	Striped marlin	52
	Blue marlin	97
	Short-billed spearfish	11
Tahiti	Blue marlin	9
Solomon Islands	Black marlin	2
Southern California	Striped marlin	99
Mexico, Baja California	Striped marlin	809
	Blue marlin	108
	Pacific sailfish	63
	Black marlin	2
	Marlin (uncl.)	1
Mazatlan to Puerto Vallarta	Striped marlin	169
	Pacific sailfish	2
	Black marlin	2
	Blue marlin	26
	Marlin (uncl.)	3
Manzanillo to Acapulco	Black marlin	1
	Blue marlin	1
Guatemala	Sailfish	1
	Blue marlin	1
Costa Rica	Sailfish	2
	Striped marlin	6
	Blue marlin	8
Panama	Striped marlin	14
	Black marlin	14
	Sailfish	32
El Salvador	Striped marlin	1
	Blue marlin	1
Indian Ocean		
Kenya	Sailfish	25
Somaliland	Blue marlin	1
Mauritius	Blue marlin	1
Totals	Striped marlin	1,150
	Blue marlin	254
	Black marlin	26
	Sailfish	125
	Short-billed spearfish	11
	Marlin (uncl.)	4
		1,570

A detailed review giving the results of the tagging program for striped marlin off Baja California, Mexico, will be published in the National Marine Fisheries Service publication, Marine Fisheries Review, scheduled for release in June 1988.

Increased tagging was reported in the Hawaiian Islands owing largely to efforts of the Pacific Game Fish Research Foundation, Kona, HI, and the Hawaiian boat captains. A total of 160 billfish were tagged and released--97 blue marlin, 52 striped marlin and 11 short-billed spearfish.

Off southern California, emphasis continued on tagging of striped marlin. Support from anglers, captains, and the National Coalition for Marine Conservation (NCMC) resulted in 99 striped marlin tagged and released in 1987. The NCMC encourages tagging by presenting an annual award to the angler and captain tagging the most billfish off southern California.

The distribution of tagging effort and number of billfish tagged by area in 1987 is given in Table 1.

Changes in Tagging Program Policy for 1988

Due to budget reductions and research needs of the Southwest Fisheries Center, we will be de-emphasizing tagging of striped marlin off the coast of Mexico and tagging of sailfish in the eastern Pacific. Instead we encourage anglers to tag and release blue marlin and black marlin off Mexico (Baja California area) and all marlin species (striped, blue and black marlin) in other areas of the Pacific and Indian Ocean. Tags will be available at fishing resorts in Mexico that have supported the program in past years for the tagging of blue or black marlin, or for special studies. These fishing resorts are Ranch Buena Vista, Spa Buena Vista and Punta Colorada in Baja California, Mexico. (J. Squire, FTS 893-7072)

Papers on Marine Mammals Prepared

R. Pitman, D. Au, M. Scott, and J. Cotton presented a working paper to the International Whaling Commission (IWC) special session on beaked whales, May 1988, in La Jolla. Their paper "Observations of beaked whales (Ziphiidae) from the eastern tropical Pacific," describes observations made by the authors while at sea aboard research and commercial tuna fishing vessels. The authors report seeing at least six species, some possibly not yet described, from 1977-1988 in the eastern tropical Pacific. They compare information on distribution and relative abundance of the species and conclude that beaked whales are more commonly encountered than any other species or species group of medium to large sized whales in the eastern tropical Pacific.

D. Au, M. Scott, and W. Perryman published a paper in "CETUS" on dolphin locomotion. The authors review the concept of "crossover speed" in "porpoising" behavior (rapid swimming by leaping). They point out discrepancies in recently published observations that peg the crossover speed at near 3.5 m/s. Using measurements from aerial photographs of leaping dolphins, Au et al. estimated mean horizontal speed to be 8.2 m/s (ca. 16 knots) and distances between leaps nearly twice the leap distance (6.8 m). This leap-swim sequence is similar to that of slowly moving dolphins and seemingly contradicts the tenants of a "crossover speed." (D. Au, FTS 893-7071)

TIBURON LABORATORY

Tiburon, California

GROUNDFISH ANALYSIS INVESTIGATION

Annual Survey of Pelagic Juvenile Rockfish Completed

The staff of the Groundfish Analysis Investigation at the Tiburon Laboratory has completed its annual survey of pelagic juvenile rockfish *(Sebastes)*. The purpose of the survey is to determine the distribution and abundance of juvenile rockfish inhabiting the waters off central California. Specifically, two cruises were made in the area between Cypress Point (Monterey County) and Point Reyes (Marin County) from April 14 to 24 and from May 20 to June 22. In April, one sweep of the survey area was made, and three sweeps were completed during the May-June cruise. The work involved daytime CTD casts and nighttime midwater trawls. Additional daytime trawls were made to compare daytime and nighttime catches.

Cruise Leader David Woodbury in cooperation with Chief Scientists Ralph Larson and Bill

Leet are pleased to report that the industrious work of both scientific party and crew of the NOAA Ship *David Starr Jordan,* with the aid of good weather, produced a very successful cruise. All stations were sampled, and additional trawls were made near an upwelling plume. Although analysis of the data is still in progress, preliminary results indicate that, compared with previous surveys, abundance was high and the pelagic juveniles were relatively large. Species that seemed particularly abundant in 1988 included shortbelly, chillipepper, squarespot, stripedtail, canary and blue rockfish.

In April, the oceanic conditions were uniform throughout the survey area with no indication of strong upwelling. During the May-June cruise, intense upwelling occurred during the first sweep, while calm weather and sea surface warming occurred during the final two sweeps. (D. Woodbury, FTS 556-0565)

GROUNDFISH COMMUNITIES INVESTIGATION

Mass Stranding of Juvenile Shortbelly rockfish and Hake Considered to be a Natural Event

Carcasses of juvenile shortbelly rockfish, *Sebastes jordani*, and hake, *Merluccius productus,* littered the shore of northern California during June. The local news media reported these strandings to be the result of a "mysterious fish-kill," and presented various hypotheses which implicated pollution, the dumping of dredge-spoils and other human activities. However, studies of the Groundfish Communities Investigation indicate these fish died of natural causes.

Investigation Leader Dr. Ted Hobson, with Fishery Research Biologists Tony Chess and Dan Howard, reported mass strandings of these same species during 1985, when conditions were similar to those of this year. Recruitment of shortbelly rockfish has been exceptionally strong this year, just as it was in 1985. Coincident with these unusually large numbers, there were unseasonal southerly winds just before the shortbellies appeared on the beach. Typically at this time of year winds come from the north, and drive the surface waters seaward, keeping the shortbellies offshore. Southerly winds drive the surface waters shoreward, bringing the shortbellies to the beach.

Observations by Hobson, Chess and Howard along the Mendocino and Sonoma coasts during June showed widespread occurrences of juvenile shortbellies near shore. The fish were densest right at the water's edge, where tightly packed schools filled the water where it was just a few meters deep. These fish were in poor condition, with many of them carrying abrasions and lacerations. On the seafloor beneath the schools lay many dead hake (Fig. 1), and these too carried numerous abrasions and lacerations. Significantly, most of the hake that were examined had guts that were full of shortbellies. No living hake were seen.

Figure 1. Dead juvenile shortbellies on the Sonoma coast.

Nearby were numerous juveniles of other rockfish species, including the blue rockfish, *Sebastes mystinus*, the black rockfish, *S. melanops*, and the yellowtail rockfish, *S. flavidus*. But these are normal inhabitants of the nearshore habitat; all of them appeared to be in good condition, and none were seen among the dead shortbellies on the beach, or in the guts of the hake.

It is clear that both juvenile shortbellies and hake, being adapted to open water, are ill-suited to the conditions they experience near shore.

Probably it is normal that hake find juvenile shortbellies major prey at this time of year, as do salmon and other coastal predators, but they are adapted to encounter them in open water. Certainly attacks adapted to open water would be perilous when performed among rocks or at the water's edge. This is especially so at night, which is when hake normally feed. Under these circumstances, inadvertent strandings or collisions with abrasive surfaces could have caused much of the observed mortality. (E. Hobson, FTS 556-0565)

INFORMATION TECHNOLOGY SERVICES

Local Area Network Installed at La Jolla

A 3COM Local Area Network (LAN) has been installed at the La Jolla Laboratory. The LAN supports 10 megabit per second data transmission using ethernet communications protocols (i.e. IEEE 802.3). The network employs a bus topology with seven distinct segments interconnected by a multiport isolating repeater. Three of the seven segments are now online and supporting Center users. There are presently 10 personal computers connected to the network. It is expected that all staff now relying on the the La Jolla Molecular 32X for word processing capability will move to the network over the period of the next year or two.

LAN software is run from a single network server (a 3COM 3Server3) which monitors and controls all traffic on the network and handles the sharing of all networked resources. Network services now include: 1) the ability to load WordStar and WordPerfect from the network server to connected personal computers (saving users the need to buy these programs), 2) shared access to networked devices such as modems and laser printers, 3) transparent access to the system's hard-disk for document/file storage, 4) daily disk back-up service for all files stored on the system hard-disk, 5) easy file exchange capability between connected users, and 6) an electronic mail (Email) service that provides efficient communications for users within the La Jolla laboratory, and interconnects with the Email service now being run at NMFS headquarters. An especially nice feature of the 3COM Email is the ease by which documents, programs, spreadsheets, etc. can be appended to Email documents and forwarded to remote destinations.

The National Data Management Committee (NDMC) has recently recommended that 3COM Email be used to replace Email services currently provided by the NOAA time-shared contractor EDS. It is now possible to access the NMFS headquarters' Email service from a remote personal computer, via a Hayes-compatible modem using "Remote Mailbox" software as prepared by headquarters' staff. (F. Ralston, FTS 893-7062)

STATUS OF PUBLICATIONS

Published

Akin, Priscilla A. 1988. Geographic variation in tooth morphology and dentinal patterns in the spinner dolphin, *Stenella longirostris*. Mar. Mammal Sci. 4(2):132-140.

Sixteen tooth characters were analyzed in 277 specimens of spinner dolphins *(Stenella longirostris)* from the eastern tropical Pacific to determine whether the characters were associated with size of the animal, species-stock membership or geographic location. The tooth characters included 5 continuous measurements and 11 qualitative variables. Statistical analyses of the characters included two-way ANOVA tests which assessed continuous measurement variables for differences based on stock membership, latitude and longitude of collection or whether the animal was collected north or south of the equator. Principal component analyses combined factors of continuous variables with those of qualitative variables into components which were used as variables in further analyses. Discriminant analyses were performed using continuous variables alone and using principal components as potentially discriminating variables. Results showed that tooth differences were not associated with size but significant differences were found in some tooth variables with stock membership, incremental changes in latitude and whether the animal was collected north or south of the equator. A discriminant function, containing only tooth length, correctly classified 67% of northern and 78% of southern animals according to location of collection north or south of the equator.

Alvariño, Angeles. 1988. *Pandea cybeles*, a new medusa from the Sargasso Sea (Coelenterata: Anthomedusae: Pandeidae). Proc. Biol. Soc. Wash. 101(1):102-108.

A new medusa is described and illustrated. It is compared to related species in the genus, *Pandea conica* (Quoy & Gaimard, 1827) and *Pandea rubra* Bigelow, 1913. It differs from those species in the proporitons of the umbrella and its conical process, number of ribs on the umbrella, number of marginal tentacles, ocelli on the basal bulb of tentacles, and the large size of the stomach. The diagnostic characteristics of these species and *Pandea cybeles* are compiled in a table. Information is included on the distribution of the species throughout the world.

Ambrose, David A., Richard L. Charter, H. Geoffrey Moser, and Bradley S. Earhart. 1988. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1975. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-110, 229 p.

Ambrose, David A., Richard L. Charter, H. Geoffrey Moser, and Bradley S. Earhart. 1988. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1981. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-112, 170 p.

Au, D. W., M. D. Scott, and W. L. Perryman. 1988. Leap-swim behavior of "porpoising" dolphins. Cetus 8(1):7-10.

Banish, L. D. and W. G. Gilmartin. 1988. Hematology and serum chemistry of the young Hawaiian monk seal (*Monachus schauinslandi).* J. Wildl. Dis. 24:225-230.

Between January 1984 and May 1987, blood samples were collected from 12 young (3- to 6-mo-old) Hawaiian monk seals *(Monachus schauinslandi)* that were captured in the wild and held in captivity. All samples evaluated were from clinically normal animals. Average hematologic and serum chemistry values were not remarkable for a young diving mammal. The blood and serum analyses performed established reference ranges, which can be used as indicators of health status for this endangered species.

Boehlert, G. W. 1988. Fishing in the Exclusive Economic Zone: The potential for island-related resources. In E. K. Datta (editor), Proceedings of Pacific Basin management of the 200-nautical mile Exclusive Economic Zone: A partnership of government and private sectors [July 9-10, 1987, Honolulu], p. 177-182. Pacific Basin Development Council, Coastal Zone Management Programs of the State of Hawaii, Territory of Guam, Territory of American Samoa, and the Commonwealth of the Northern Mariana Islands, and Pacific and Asian Affairs Council.

Dailey, M. D., R. V. Santangelo, and W. G. Gilmartin. 1988. A coprological survey of helminth parasites of the Hawaiian monk seal from the Northwestern Hawaiian Islands. Mar. Mammal Sci. 4:125-131.

In conjunction with an Hawaiian monk seal, *Monachus schauinslandi*, breeding enhancement program, fecal samples were examined for the presence of helminth parasite products (eggs, larvae, and proglottids). Eighty-two samples were examined from four island groups in the northwestern Hawai ian Islands: 38 from Kure Atoll, 32 from French Frigate Shoals, 11 from Laysan Island, and one from Lisianski Island. Identified helminth products include those of *Diphyllobothrium* sp., *D. cameroni, Contracaecum turgidum, Anisakis sp., Corynosoma rauschi,* and *Trematoda.* In addi tion, eggs from *Halarachne laysanae* (Acari) were found in 3 samples. Eggs of *C. turgidum* were present in the highest percentage (64%) of samples from all locations. Eggs of *Anisakis sp.* and *Trematoda* are reported from this host for the first time.

Lasker, Reuben. 1988. Studies on the northern anchovy; biology, recruitment and fishery oceanography. Studies on Fisheries Oceanography. Edited by Japanese Society of Fisheries Oceanography, p. 23-42.

Leet, Maureen H. and Carol A. Reilly. 1988. Annotated bibliography of the genus *Sebastes* (family Scorpaenidae). Pac. Mar. Fish. Comm., Portland, Oregon, 249 p.

This bibliography on genus Sebastes (family Scorpaenidae) contains 1,258 references on the taxonomy, distribution, abundance, life history, fisheries management, and ecology of North Atlantic redfishes and Pacific rockfishes. The purpose of the project is to coordinate and organize the scientific literature on Sebastes and make a useful bibliography available to researchers working on rockfish. It is based on records downloaded from literature searches done on a variety of online databases and references gathered from bibliographic sources. Materials dating from the eighteenth century to the end of 1987 are cited. Abstracts accompany many citations. This bibliography was completed in February, 1988.

A disk version of the *Sebastes* bibliography is being distributed by American Fisheries Society Computer User Section. The file is available in two versions. A text or ASCII file accompanied by LIST, a shareware program for scanning and extracting information from text files, is available as AFSCUS 21 and AFSCUS 22 at a cost of $5.00 per set of diskettes. For those who have the Sci-Mate Software System, a Sci-Mate User file is available as AFSCUS 23 and AFSCUS 24 at a cost of $5.00 per set of diskettes.

To order disk copies of the Sebastes bibliography, contact Anthony Frank, AFSCUS Librarian, 1451 Green Road, Ann Arbor, MI 48105, (313) 994-3331.

Paper copies of this document are available from Pacific Marine Fisheries Commission, Metro Center Suite 70, 2000 SW 1st Street, Portland, OR, 97201, (503) 294-7025.

Ralston, Stephen V. and Happy A. Williams. 1988. Depth distributions, growth, and mortality of deep slope fishes from the Mariana Archipelago. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-113, 46 p.

Sandknop, Elaine M., Richard L. Charter, H. Geoffrey Moser, Cynthia A. Meyer, and Amy E. Hays. 1988. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1978. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-111, 216 p.

Shomura, R. S. 1988. Migration patterns of tuna in the Pacific. In E. K. Datta (editor), Proceedings of Pacific Basin management of the 200-nautical mile Exclusive Economic Zone: A partnership of government and private sectors [July 9-10, 1987, Honolulu], p. 183-189. Pacific Basin Development Council, Coastal Zone Management Programs of the State of Hawaii, Territory of Guam, Territory of American Samoa, and the Commonwealth of the Northern Mariana Islands, and Pacific and Asian Affairs Council.

Sumida, Barbara Y., Richard L. Charter, H. Geoffrey Moser, and Deborah L. Snow. 1988. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1972. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-109, 219 p.

Thayer, Victoria G., Stephen B. Reilly, Paul C. Fiedler, Charles W. Oliver, and David W. Behringer. 1988. Report of ecosystem studies conducted during the 1987 eastern tropical Pacific dolphin survey on the research vessel *MacArthur.* U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-114, 17 p.

Thayer, Victoria G., Stephen B. Reilly, Paul C. Fiedler, Robert L. Pitman, Gregg G. Thomas, and David W. Behringer. 1988. Report of ecosystem studies conducted during the 1987 eastern tropical Pacific dolphin survey on the research vessel *David Starr Jordan.* U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-115, 18 p.

Wetherall, J. A., J. J. Polovina, and S. Ralston. 1987. Estimating growth and mortality in steady-state fish stocks from length-frequency data. In D. Pauly and G. R. Morgan (editors), Length-based methods in fisheries research, p. 53-74. ICLARM Conference Proceedings 13, International Center for Living Aquatic Resources Management, Manila, Philippines, and Kuwait Institute for Scientific Research, Safat, Kuwait.

Methods of using length-frequency statistics to estimate L and the ratio Z/K in steady-state fish stocks with von Bertalanffy growth and exponential mortality are studied. Several standard procedures applicable when mortality is constant are reviewed, and new methods are introduced which have superior performance. The various methods are evaluated using Monte Carlo techniques. Problems of systematic bias are discussed, and remedial measures are suggested. Finally, a method is developed (but not yet evaluated) to estimate length-specific mortality rates under the steady-state model.

Approved by Science and Research Director, Southwest Region

Brill, Richard W. and Peter G. Bushnell. CARDIO--A Lotus 1-2-3 based computer program for rapid calculation of cardiac output from dye or thermal dilution curves. For consideration for publication in American Physiological Society, Special Communication.

Gerrodette, Tim and Douglas P. DeMaster. Quantitative determination of optimum sustainable population level. For consideration for publication in Marine Mammal Science.

Hewitt, Roger. Introduction to the proceedings of the 1987 CalCOFI Symposium. For consideration for publication in Calif. Coop. Oceanic Invest. Rep.

Holts, David and Dennis Bedford. 1988. Activity patterns of striped marlin in the Southern California Bight. For publication in the Proceedings of the International Billfish Symposium.

Huppert, Daniel D. Marine fishery regulation in the U.S. and the role of economic analysis. For publication in the Proceedings of the Symposium on Marine Fishery Allocations and Economic Analysis.

Myrick, A. C., Jr. P. K. Yochem and L. H. Cornell. Toward calibrating dentinal layers in captive killer whales by use of tetracycline labels. For consideration for publication in Rit Fiskideildar.

Okada, M., T. Machino and S. Kato. "Bone-softening," a practical means of utilizing small fish. For consideration for publication in Marine Fisheries Review.

Polovina, Jeffrey J. A system of simultaneous dynamic production and forecast models for multispecies or multiarea applications. For consideration for publication in the Canadian Journal of Fisheries and Aquatic Science (Note).

Seki, Michael P. and Michael W. Callahan. The feeding habits of two deep slope snappers, *Pristipomoides zonatus* and *P. auricilla,* at Pathfinder Reef, Mariana Archipelago. For consideration for publication in Fishery Bulletin, U.S. (Note).

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Ueber, Edward. Fillet yield of sablefish versus fish length. For consideration for publication in North American Journal of Fisheries Management.

Ueber, Edward. *Xanthic gigantic* China rockfish. For consideration for publication in California Fish and Game.

Translation

M. E. Vinogradov, and M. V. Flint (editors). 1985. Biological bases of the commercial exploitation of the open areas of the ocean. Academy of Sciences of the U.S.S.R., Commission on Problems of the World Ocean, Nauka Publ., Moscow. (Engl. transl. by W. G. Van Campen, 1988, 12 p., Transl. No. 127; available Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396.) [Table of Contents and Abstracts only.]

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Laurs, R. Michael and Ronald J. Lynn. 1988. North Pacific albacore oceanography. SWFC Admin. Rep., La Jolla, LJ-88- 13, 59 p.

Lo, Nancy C.H. 1988. Preliminary spawning biomass estimate of the northern anchovy in 1988. SWFC Admin. Rep., La Jolla, LJ-88-17.

Pooley, S. G. 1988. Western Pacific pelagic fisheries in 1987. SWFC Admin. Rep., Honolulu, H-88-11, 26 p.

Pooley, S. G., and K. E. Kawamoto. 1988. Status of Hawaii's bottom fish fishery in 1987. SWFC Admin. Rep., Honolulu, H- 88-10, 17 p.

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Richter, Tracy Jo. 1988. A temporal comparison of survivorship patterns in three species of captive cetaceans. SWFC Admin. Rep., La Jolla, LJ-88-14, 20 p.

Somerton, D. A. 1988. Assessment of the stock condition of pelagic armorhead on Southeast Hancock Seamount. SWFC Admin. Rep., Honolulu, H-88-9, 7 p.

Stewart, Brent S. and Pam Yochem. 1988. Aerial surveys of pinniped populations in the Channel Islands National Park and Channel Islands National Marine Sanctuary; 1985-1986; 1986-1987. SWFC Admin. Rep., La Jolla, LJ-88-15, 32 p.

Wexler, Jeanne and Charles W. Oliver. 1988. Pinniped research conducted at San Clemente Island during 1984. SWFC Admin. Rep., La Jolla, LJ-88-16.

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